DESCRIPTION

PACKET COMMUNICATION APPARATUS AND TRANSMIT POWER CONTROL METHOD

Technical Field

The present invention relates to a packet communication apparatus and transmit power control method used in a radio communication system.

Background Art

It is required in a packet communication for a receiving station to receive a packet or a transmission unit, which is obtained by dividing the packet into portions, transmitted from a transmitting station through a propagation path without data error. Therefore, the transmitting station generally performs error correcting coding per unit transmission portion, and the receiving station performs error detection and error correction per unit transmission portion.

It sometimes happens during the time a packet is transmitted that an error beyond the capability of the error correcting coding occurs on a transmission unit, and therefore cannot be corrected. In such a case, a receiving station abandons the packet, and requests a transmitting station to retransmit the packet.

In order to perform stable communications in the case of performing a packet communication in a radio

communication where a propagation path environment changes rapidly, there is proposed a method in which power control is performed in addition to the above error correcting coding (Japan Laid Open Patent Publication HEI9-233021). The power control is performed in such a way that a quality on a propagation path is estimated from a received signal, and deterioration on the propagation path is corrected corresponding to the estimated quality.

Specifically, a receiving station detects a quality of received signal per packet or unit transmission portion, estimates a propagation path environment based on the received quality, generates power control information corresponding to the propagation path environment, and transmits a signal including the power control information to a transmitting station. The transmitting station adjusts transmit power based on the power control information.

FIG.1 is a schematic view showing a quality of received signal and power control status in a conventional packet communication apparatus when a propagation path quality is deteriorated for a long period of time. In FIG.1, reference numeral "1" denotes a transmission packet, and reference numeral "2" denotes a transmission unit. Reference numeral "3" denotes a change in the received quality in a packet receiving station. In FIG.1, "up" indicates that the transmitting station receives

transmit power information for a power increase and "eq" indicates that the transmitting station receives transmit power information for maintaining power.

When the received quality, i.e., received quality 3 deteriorates on transmission packet 1 or unit transmission portion 2, a transmitting station performs control for increasing transmit power successively a plurality of times. In response to this control, the transmitting station increases the transmit power, as shown in FIG.1.

However, in such a condition that the control for increasing the transmit power is performed successively, it is considered to happen often that there is an error on a transmission unit received before the transmit power is increased, or an error that cannot be corrected occurs on a transmission unit that is transmitted with increased transmit power, and that retransmission of the packet is needed because the packet is not constructed.

Therefore, although the power control is performed based on a quality of received signal and transmit power is increased, when retransmission of a packet is needed because there is an error on a transmission unit received before the transmit power is increased, or an error that cannot be corrected occurs on a transmission unit, the retransmission of the packet is sometimes unavoidable due to the error on the received unit transmission portion. Further, increasing the transmit power may increase

interference in peripheral communication stations. Accordingly in this case, the power is consumed wastefully, resulting in a problem that an efficient packet communication is not performed.

Disclosure of Invention

It is an object of the present invention to provide a packet communication apparatus and transmit power control method that make possible battery saving and reduced interference against other communication stations.

According to the present invention, when a communication channel is in deteriorated conditions, the transmit power of the transmission units in a packet transmitting through this channel will not be increased. Instead, power control information will be saved and this control information will be reflected in the transmission of the next packet, thereby reducing interference against nearby communication stations, improving the efficiency of the packet communication, and reducing overall transmit power, thus making possible battery saving.

Brief Description of Drawings

FIG.1 is a schematic view showing a quality of received signal and power control status in a conventional packet communication apparatus;

FIG.2 is a block diagram illustrating a

configuration of a packet communication apparatus according to a first embodiment of the present invention;

FIG.3 is a schematic view showing a quality of received signal and power control status in the packet communication apparatus according to the above embodiment;

FIG.4 is a flowchart to explain an operation of the packet communication apparatus according to the above embodiment;

FIG.5 is a block diagram illustrating a configuration of a packet communication apparatus according to a second embodiment of the present invention;

FIG.6 is a schematic view showing a quality of received signal and power control status in the packet communication apparatus according to the above embodiment; and

FIG.7 is a flowchart to explain an operation of the packet communication apparatus according to the above embodiment.

Best Mode for Carrying Out the Invention

Embodiments of the present invention are explained specifically below with reference to accompanying drawings.

(First embodiment)

The first embodiment will be described with reference to a configuration, whereby a packet that keeps

receiving control for increased transmit power a number of times is determined to contain an error that makes restructuring of the packet difficult after reception, and determined to be likely to be retransmitted, and whereby the transmit power of the subsequent transmission units in this packet will not be increased, and, instead, the transmit power information will be saved and then reflected in the transmission of the next packet.

FIG.2 is a block diagram illustrating a configuration of a packet communication apparatus according to the first embodiment of the present invention.

A signal transmitted from a communication partner is received at radio reception section 102 through antenna 101. Radio reception section 102 performs amplification (gain control), down-conversion and A/D conversion of the received signal. This A/D converted signal is sent to demodulation section 105, and demodulated there and acquired as the received data. The A/D converted signal is also sent to received quality detecting section 103 and to transmit power information extracting section 106.

Received quality detecting section 103 measures, for example, the SIR (Signal to Interference Ratio) and received power, to detect the received quality of the signal. The detection result of the received quality is sent to determining section 104. Based on this detection result, determining section 104 determines

whether to increase, maintain or decrease transmit power, and outputs transmit power instruction information to modulation section 108.

Transmit power information extracting section 106 extracts the transmit power information from the A/D converted signal, and inputs the transmit power information to counter 1071 in transmit power control section 107.

In transmit power control section 107, counter 1071 counts the number of times transmit power information is input. Count control section 1072 in transmit power control section 107 controls transmit power in respect to radio reception section 109 according to the transmit power information, while monitoring the count number on counter 1071 and instructing start and halt of transmit power control. Further, count control section 1072 resets counter 1071. Memory 1073 stores transmit power information.

Meanwhile, transmission data is sent to modulation section 108 with the transmit power instruction information, modulated, and then sent to radio transmission section 109. Radio transmission section 109 performs D/A conversion, up-conversion and amplification (gain control) of the modulated signal. The signal processed thus is transmitted through antenna 101 as a transmission signal.

An explanation is given of the operation of the

packet communication apparatus with the above configuration.

Radio reception section 102 performs predetermined processing on a received signal, and sends this signal to transmit power information extracting section 106. Transmit power information extracted in transmit power information extracting section 106 is input to counter 1071 in transmit power control section 107. According to the transmit power information, transmit power control section 107 instructs radio transmission section 109 to increase or decrease transmit power. When radio transmission section 109 keeps receiving instructions for increased power a number of times, transmit power control section 107 will not increase the transmit power of the subsequent transmission units in a packet but instead store the transmit power information in memory 1073, and reflect the transmit power information, collectively, upon the transmission of the next packet starts.

Specifically, counter 1071 first counts how many times the transmit power information for increased power continues. Count control section 1072 monitors whether or not the transmit power information for increased power continues a certain number of times. For example, the count number of the transmit power information for increased power is compared with a threshold.

When transmit power control section 107 detects a

situation where the transmit power information for increased power continues a certain number of times--for example, when the number of times the transmit power information for increased power continues exceeds a threshold--transmit power control section 107 will not provide instruction signal for increased power to radio transmission section 109 with respect to the subsequent transmission units in the packet, but instead store the transmit power information in memory 1073. After that, upon transmission of the next packet, transmit power control section 107 extracts the transmit power information stored in memory 1073, and sends instruction signal to radio transmission section 109 so as to reflect all the transmit power information.

Meanwhile, if the transmit power information for increased power does not continue a certain number of times, transmit power control section 107 will send the instruction signal for increased or decreased power to radio transmission section 109 according to the transmit power information. Radio transmission section 109 adjusts the gain according to the instruction signal using a gain controller such as an amplifier, thereby performing transmit power control.

This power control is performed as shown in FIG.3. When packet 201 is divided into a plurality of transmission units 202 and these multiple transmission units are transmitted in order, if received quality 203

deteriorates due to changes in the propagation path, the transmit power information for increased transmit power will be sent under the transmit power control. In FIG.3, "up" indicates that the transmitting station receives transmit power information for increased power, "eq" indicates that the transmitting station receives transmit power information for maintaining power, and "down" indicates that the transmitting station receives transmit power information for decreased power. In this case, when the instruction for increased power continues a certain number of times (four times in FIG.4), transmit power control will be halted for the subsequent transmission units. In the case of FIG.3, the last transmission unit is not given transmit power control. In FIG.3, the last unit transmission portion of the packet does not undergo the transmit power control.

That is, in FIG.3, even if the transmit power information for increased power is received for a fifth time, the last unit transmission portion of the packet that is going to be transmitted next will not be given transmit power control. In this case, the transmit power information for the last transmission unit in the packet is stored in memory, and reflected in the transmit power control on the beginning transmission unit of the next packet. By this means, adequate transmit power control will be performed from the next packet signal forward. It is therefore possible to perform efficient

communications while decreasing interference in other stations.

The transmit power control method as described above is next explained using a flowchart in FIG.4.

In step (hereinafter "ST") 301, transmit power information is extracted from a received signal. ST302 determines whether or not a flag is set indicating that this transmit power information has continued a certain number of times.

When this flag is not set, determinations are made as to whether the transmit power information is for increased power and whether that instruction for increased power continues a certain number of times (ST303). When the power increasing instruction continues a certain number of times, the flag is set (ST304). When the power increasing instruction does not repeat a certain number of times, power control is performed according to the transmit power information (ST307). Further, when the flag is set, the transmit power information is stored in the memory (ST305), and the power control is halted (ST306).

When the power increasing instruction continues a certain number of times, the transmit power information is stored in the memory (ST305), and the power control is halted (ST306). Then, the transmit power information stored in the memory is reflected in the transmit power control of the beginning transmission unit of the next

packet.

The situation where control for increased transmit power continues indicates a situation where deteriorating received signal quality due to propagation path degradation is not compensated enough. In this case, it is likely that the transmission units are not received accurately and the packet will be later retransmitted.

According to the transmit power control method of this embodiment, continuous transmit power information is counted, and, when the information for increased power continues a certain number of times or more, the transmit power information is stored and the power control is halted, thereby minimizing wasteful power consumption by not increasing the transmit power. Further, the stored transmit power information is reflected in a transmission unit of the next slot, thereby making possible secure packet transmission.

Furthermore, since transmission is not performed applying unreasonably high power to a poor-quality communication channel, it is possible to reduce interference in nearby communication stations, increase the efficiency of packet communication, and decrease overall transmit power, and achieve battery saving.

(Second embodiment)

A second embodiment will be described with reference to a configuration, whereby, when a packet keeps receiving control for increased transmit power a number of times,

only those transmission units in the packet that are used in received quality determination at the receiving end will have increased transmit power, and whereby the transmit power of the immediately last pilot signal is reflected upon all transmission units when the next packet is transmitted.

FIG.5 is a block diagram illustrating a configuration of a packet communication apparatus according to the second embodiment of the present invention. In addition, in FIG.5, the same sections as those illustrated in FIG.2 are assigned the same reference numerals as those in FIG.2 to omit detailed explanations thereof.

In the configuration illustrated in FIG.5, a configuration of transmit power control section 401 is different from a corresponding configuration illustrated in FIG.2. That is, transmit power control section 401 has counter 4011 that counts the number of transmit power information, count control section 4012 that controls transmit power on a control channel for transmitting, for example, a pilot signal, and transmit power on a data channel for transmitting data independently to increase or decrease respective power corresponding to the count number on counter 4011, control channel power control section 4013 that performs power control on the control channel, and data channel power control section 4014 that performs power control on the data channel.

An explanation is given of the operation of the packet communication apparatus with the above configuration.

Radio reception section 102 performs predetermined processing on a received signal, and sends this signal to transmit power information extracting section 106. Transmit power information extracted in transmit power information extracting section 106 is input to counter 4011 in transmit power control section 401. According to the transmit power information, transmit power control section 401 provides an instruction for increasing or decreasing transmit power on the control channel to radio processing section 109, while. When transmit power control section 401 keeps receiving the transmit power information for increased power a number of times, transmit power control section 401 will not increase the transmit power of the subsequent transmission units in the packet. Then, on the control channel, the transmit power of the immediately last control signal will be reflected in the transmit power of the signal portion of the data channel (i.e. data signal portion) when the transmission units of the next packet starts.

Specifically, counter 4011 counts the number of times the transmit power information for increased power continues in the data channel. Count control section 4012 monitors whether or not the transmit power information for increased power continues a certain

number of times. For example, the count number on the transmit power information for increased power is compared with a threshold.

Then, when transmit power control section 401 detects a situation where the transmit power information for increased power continues a certain number of times--for example, when the number of times the transmit power information for increased power continues exceeds a threshold--instruction signal for halting power control with respect to the subsequent transmission units in the packet will be sent to data channel power control section 4014. Data channel power control section 4014 controls radio transmission section 109 so that radio transmission section 109 halts the power control of the subsequent transmission units of the packet.

Meanwhile, as for the control channel, control channel power control section 4013 controls radio transmission section 109 so that radio transmission section 109 increases or decreases power according to the transmit power information. Radio transmission section 109 adjusts the gain according to the instruction signal using a gain controller such as an amplifier, thereby performing transmit power control.

Then, with respect to the control channel, count control section 4012 instructs radio transmission section 109 to reflect the transmit power of the immediately last control signal (e.g., pilot signal) in the transmit power

of the data signal when the transmission of the transmission units of the next packet starts.

This power control is performed as shown in FIG.6. When packet 501 is divided into a plurality of transmission units 502 and these multiple transmission units are transmitted in order, if received quality 503 deteriorates due to changes in the propagation path, transmit power information for increased transmit power will be sent under the transmit power control.

In FIG.6, "up" indicates that the transmitting station receives transmit power information for increased power, "eq" indicates that the transmitting station receives transmit power information for maintained power, and "down" indicates that the transmitting station receives transmit power information for decreased power.

In this case, when the instruction for increased power continues a certain number of times (four times in FIG.6), transmit power control will be halted for the subsequent transmission units. In the case of FIG.6, the last transmission unit is not given transmit power control. In FIG.6, the last unit transmission portion of the packet does not undergo the transmit power control. That is, in FIG.6, even if the transmit power information for increased power is received for a fifth time, the last unit transmission portion of the packet that is going to be transmitted next will not be given transmit power control. Meanwhile, the transmit power control is

performed on each transmission unit of a pilot signal that transmits on the control channel according to the transmit power information. Then, on the data channel, the transmit power control on the beginning transmission unit of the next packet is performed according to the transmit power information of the immediately last pilot signal. In other words, with the data signal, the transmit power information of "H," which combines h1 and h2, in FIG.6 is reflected upon the beginning transmission unit of the next packet.

The transmit power control method as described above is next explained using a flowchart in FIG.7.

In ST 601, transmit power information is extracted from a received signal. ST602 determines whether or not a flag is set indicating that this transmit power information has continued a certain number of times.

When this flag is not set, determinations are made as to whether the transmit power information is for increased power and whether that instruction for increased power continues a certain number of times (ST603). When the flag is set, transmit power control will be performed only with respect to the pilot signal in the control channel according the transmit power information (ST605). In other words, the transmit power control is halted on the signal potion of the data channel (ST605). With the beginning transmission unit of the next packet, power control for the data signal is performed

(ST607).

Further, when the instruction for increased power continues a certain number of times, the flag is set (ST604), and the transmit power control is performed only with respect to the pilot signal of the control channel according to the transmit power information (ST605). In other words, the transmit power control is halted on the data signal.

When the instruction for increased power does not continue a certain number of times, the power control is performed on the data channel and control channel for each unit transmission portion according to the transmit power information (ST606).

The situation where control for increased transmit power continues indicates a situation where deteriorating received signal quality due to propagation path degradation is not compensated enough. In this case, it is likely that the transmission units are not received accurately and the packet will be later retransmitted.

According to the transmit power control method of this embodiment, continuous transmit power information is counted, and, when the information for increased power continues a certain number of times or more, the pilot signal alone will have increased transmit power and the transmit power of the data signal will not be increased. By this means, it is possible to maintain accurate operation of power control with respect to the receiving

station that determines received quality from the pilot signal and prevent transmission applying excessive power. As a result, it is possible to reduce interference in the surroundings and increase the efficiency of packet communication. Further, the transmit power information for the pilot signal is reflected at upon the transmit power information for the pilot signal when the transmit power control of the data signal starts, thereby securing the transmission of the packet.

Thus, on a poor-quality communication channel, controlling transmit power of the pilot signal and the data signal separately makes it possible to maintain accurate operation of the power control and prevent transmission applying excessive power. By this means, it is possible to reduce interference in nearby communication stations, increase the efficiency of packet communication, and perform more proper transmit power control upon next packet transmission.

The packet communication apparatus according to the first or second embodiment is applicable to a base station apparatus and a communication terminal apparatus such as a mobile station in a digital radio communication system. The present invention thus enables radio communications at an excellent level of efficiency at minimum power.

The present invention is not limited to the abovementioned embodiments, and is capable of being carried into practice with various modifications thereof.

For example, while the above embodiments explain the case where as a method of determining quality deterioration, the method is used of counting the number of times the instruction for increasing transmit power continues, another method is applicable in the present invention as the method of determining quality deterioration. In other words, the method of determining quality deterioration is not limited to any particular one in the present invention.

As described above, the packet communication apparatus of the present invention is capable of performing power control adapted to packet communications, suppressing excessive power control for compensating for deterioration of communication path quality, and decreasing interfering power in peripheral communication stations and also total transmit power.

This application is based on the Japanese Patent Applications No.HEI11-156663 filed on June 3, 1999, and No.HEI11-188649 filed on July 2, 1999, entire contents of which are expressly incorporated by reference herein.

Industrial Applicability

The present invention is applicable to a base station apparatus and communication terminal apparatus in a digital radio communication system.